Digital Communications Lab

Lab #3

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Experiment

1. Generate a random data signal using a maximal length LSFR (like you built in lab #2) clocked at 10 kHz. Pass the signal through a low pass filter. Ideally you should use one of the Non-white adjustable filters available in the laboratory. If you do not have access to one of these filters, you can approximate it with an R/C circuit such as the one you built in laboratory #1. Adjust the cutoff frequency of the filter from 1 kHz to 100 kHz, and watch how it distorts the signal. In particular look at how it distorts data when there is a long string of 1's or 0's in a row, and also look at how it distorts the data when you have a pattern like 0001000 or 1110111. Describe this distortion in your report. In digital communication systems we usually don't care if the waveform at the receiver looks like a perfect logic signal, we just need to be able to determine if the original signal was a 0 or a 1. If the cutoff frequency of the low pass filter is very high, this should not be a problem. But as you lower the cutoff frequency, it becomes increasingly difficult to determine the bits. What range of cutoff frequencies allow you to "easily" determine if the original data was a 0 or 1? What data patterns are most difficult to detect? For example is 000000111111100000 difficult to detect, or 00110011001100110011, or 010101010101, or 00000000100000, or some other?

2. We now want to look at what frequencies the digital signal is using. The spectrum analyzer will do this for us. Start by connecting a sine wave generator to the spectrum analyzer. Have one person in your lab team set the amplitude and frequency of the sine wave generator, and then have someone else (who can't see these settings) see if they can figure them out by looking at the spectrum analyzer display.

3. Put the random data signal into a spectrum analyzer, and determine what range of frequencies it uses. Sketch the plot in your report. If possible plot it both on a linear scale, and a dB scale. Describe how the plot changes if you alter the clock frequency of the data signal, and also if you alter the amplitude of the data signal.

4. Put random data through a low pass filter, as you did in step 1 above. Look at the output of the low pass filter on the spectrum analyzer. Reduce the cutoff frequency of the filter, until the data starts getting so badly distorted, that you can no longer clearly make out all the 1's and 0's (when viewed on an oscilloscope). Once you find that point again, look at the spectrum of the signal. What range of frequencies seem to be absolutely essential for us to keep, and what frequencies are there just to make the signal look pretty? By absolutely essential, I mean frequencies required so we can distinguish logical 1's and 0's. By pretty, I mean frequencies that give us sharp edges on those 1's and 0's, but don't change our mind about which bit was transmitted.